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Research Article

Introduction of Problem Based Learning and Its Comparison with Conventional Lecture Based Learning in Pharmacology for Undergraduates

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Abstract: Presently medical students must memorise numerous detailed facts about drugs and pharmacologically active substances without a direct clinical context. There is a need to encourage application of the knowledge to real-life scenarios, foster safe practice and enhance the confidence in treating clinical patients who are taking multiple medications. Facilitated teaching should be promoted instead of factual teaching which is routinely practiced in India. Learning involves a change in the learner's behaviour. Problem-based learning (PBL) promotes integration of knowledge and fosters a deeper approach to life-long learning. There is a lacuna of PBL teaching in the Department of pharmacology in our college. Introduction of PBL will be an innovative effort in this regard. Aim of the study is to determine the levels of learning achieved by the learners as a result of the intervention viz., PBL and conventional Lecture Based Learning (LBL) and efficacy of the teaching and learning method in achieving the learning objectives/outcomes in pharmacology subject. Present study involves true experimental design and Randomised, Controlled study. Two groups consisting of second MBBS students (sample) will be exposed to conventional LBL (active control group) and PBL. Pre and post test (by using M.C.Qs) and attitude/feedback tests (by using Likert's-type questions/items) will be conducted.Clinical application of knowledge will be assessed. Data will be collected and analyzed by using standard statistical tests ($p<0.05$). PBL may be used as an adjunct to or as a replacement for conventional LBL in pharmacology. Accordingly, modifications will be done in the curriculum (syllabus) of the University.
Keywords: Active, Learning, Lecture, Passive, Pharmacology, Problem based, Undergraduates.

INTRODUCTION

Pharmacology is one of the essential subjects needed for further graduation in both preclinical and clinical area [1]. Pharmacological textbooks are often too drug-centred. Presently medical students must memorise numerous detailed facts about drugs and pharmacologically active substances without a direct clinical context [1]. Learning involves a change in the learner's behaviour [2]. There is a need to promote facilitated teaching instead of factual teaching which is routinely practiced in India. Professional curriculum should address environmental, cultural and social components rather than only didactic and experiential courses [3].

In 1969, PBL was first implemented by the McMaster University medical school [4]. In PBL, students learn the subject by solving problems and reflecting on their experiences [5]. Problem based learning (PBL) involves: learning environment where the problem (a patient case history etc) drives the learning, small groups, facilitators, student engagement, interactive learning, critical thinking, self directed learning, problem-solving skills, interdisciplinary studies etc [5]. Reflecting on the relationship between problem solving and learning forms a critical component of PBL which is needed to support the construction of extensive and flexible knowledge [6]. How to choose medicines based on the objectives, scientific principles and to use them in a safe and effective manner is a major challenge in teaching pharmacology to students [7]. PBL intend to enhance and optimize the educational outcomes of learner-centred, collaborative, contextual, integrated, self-directed and reflective learning [4]. PBL is learning by reflective thinking [8]. PBL is a methodology which is known to promote the integration of knowledge and foster a deeper approach to life-long learning [9,10].

Teaching of pharmacology in the Department of pharmacology, Jawaharlal Nehru Medical College routinely involves conventional lecture based learning

(LBL). In the present study which is a conceptual paper, strategies to introduce PBL and its evaluation are elaborated, which will be an innovative and important step towards training of a lifelong reflective practitioner.

MATERIALS AND METHODS

Aim of the present study is to determine the levels of learning achieved by the learners as a result of the intervention viz., PBL and conventional LBL and efficacy of the teaching and learning method in achieving the learning objectives/outcomes in pharmacology subject.

Research Question: Performance of undergraduates trained under PBL differs when compared to that of undergraduates trained under conventional LBL in pharmacology. *"Performance"* includes undergraduates' scores on knowledge tests, attitude tests, tests regarding application of knowledge and clinical skills. This will assess learning by the under graduates.

Null hypothesis H_0: There is no difference in performance of undergraduates between LBL groups when compared to that of PBL group. H_0: $\mu_{LBL} = \mu_{PBL.}$ Alternative hypothesis H_1: Performance of undergraduates in LBL group differs when compared to that of PBL group. H_1: $\mu_{LBL} \neq \mu_{PBL.}$ Descriptive hypothesis H_D: Performance of undergraduates in LBL group is better when compared to that of PBL group or vice versa. H_D: $\mu_{LBL} >$ or $< \mu_{PBL.}$

Tests will be conducted as follows:
R O1 --------- XLBL---------- O2, O3, [O4],[O5]
R O1, O6 --------- XPBL ---------- O2,O3,[O4],[O5],O7
XLBL = Group exposed to conventional Lecture Based Learning.
XPBL = Group exposed to Problem Based Learning.

O means outcome.
O1 = Pre-test consisting 60 M.C.Qs (cognition-pharmacology).
O2 = Post-test consisting 60 M.C.Qs which are used for pre-test.
O3 = Post intervention 120 M.C.Qs.
[O4] = Scores on Objective Structured Clinical Examinations (OSCE) conducted for both the groups separately.
[O5] =Attitude/feedback test (by using Likert's-type questions/items) for both the groups.
O6 = Pre-test consisting 60 MCQ's (cognition regarding PBL).
O7 = Post-test consisting 60 MCQ's which are used for pre-test i,e, for O6.

If the results suggest that there is no significant difference in performance (cognitive knowledge, etc) between LBL group and PBL group ***or*** performance is better in latter than that of the former group then the PBL can be acceptable as an alternative(or adjunct) to the conventional LBL. Results of tests regarding PBL will indicate how much training regarding PBL is effective. Follow up will be done after six months.

Medical colleges in India follow the rules and syllabus defined by the Medical Council of India (MCI), a regulating authority. Target population will be MBBS (second phase) students in medical colleges in India (generalisable). KLE University's undergraduates will be the sample population. Sample involve of second year MBBS students. A statistician will be helping to calculate the Sample size. Confounding variables like differences between instructors, pre-intervention knowledge, blindness of pre and post intervention tests, drop outs for follow-up studies etc will be considered [11]. MBBS students (n=112) in the second phase will be learning pharmacology subject for 1 and 1/2 years. Routinely they will be learning the pharmacology subject in LBL. Present research project involves true experimental design and Randomised, Controlled study. All the students will appear for a pre (intervention) test of 60 MCQs. Students will be categorised into high and low scorers depending on their scores. After randomisation, these students will be equally distributed in to two groups' viz., exposing to conventional LBL (active control group) and PBL.

Fifty six students in PBL group will be again subdivided into groups of eight members each. Post (intervention) test will be conducted with the help of 60 MCQs + 120 MCQs (Table-1). Pre-test consisting 60 MCQs (cognition regarding PBL) will be administered to PBL group and same will be used after the intervention as Post-test. Students' attitude/perception regarding both the type of intervention or instruction methods i.e., LBL and PBL will be obtained. Participants are required to indicate their agreement or otherwise with the modified Likert's-type scale items by ticking one of the five alternatives (5 point scale) viz., strongly agree, agree, neither agree or disagree, disagree and strongly disagree[12] (Table-2). Precaution is taken so as to confirm that both interventions achieve the learning objectives. Problems for PBL (Table-3) will be designed with the help of subject experts.

In PBL group, through problem trigger, learner explores ideas within contexts and integrates new concepts with his prior knowledge and through reflection, constructs a personal understanding of the knowledge [13]. Once every two weeks, 'Time out' will be called and the group will be encouraged to reflect on how their studies are progressing and how their learning fits together. Students will reflect on: the propositional knowledge, processes involved in understanding the content, how they worked as a team member and have contributed to the group's work [8]. Seven classical steps of PBL viz., understand the situation/clarify terminology; identify the problem; suggest possible

causes (hypothesize); connect problems and causes; decide what type of information is needed; acquire information and apply the information, will be used for the PBL group [14]. A tutor will be progressively disclosing the problem to the tutorial groups of 8 students. In the first tutorial students will be given a short scenario, followed by the progressive revelation of the patient's history, physical examination findings and investigation results (10-15 min brainstorming will be done for finding possible solutions/hypotheses based on the available information and then decide, what further information is needed to solve the problem and to test the hypotheses.). Learners spend a week between tutorials researching a set of agreed learning issues (1 wk). Learners will be applying the knowledge and understanding gained from their self-directed study to the problem in the second week (2-3 wk). Further information on the patient's progress and the results of investigations will be revealed, which will be used to finalize their hypotheses and to resolve outstanding questions. At the end of second tutorial, patient's prognosis and follow-up treatment will be disclosed (3-4 wk). Many drugs can be introduced at this time. Learning aspects considered are: to engage students in a search for information/knowledge about the basic physiology, mechanism of action of pharmacological agents at those molecular structures, the drugs they will prescribe, why this dose?, why this frequency?, planning a management strategy, review of factors that can interfere with the management plan, drug selection, patient education, cautioning about adverse effects, monitoring of therapeutic efficacy and safety, clinical response, laboratory findings, assessment of the need to continue/modify/terminate therapy etc[15-17].

Assessment method and the assessment instrument used can influence what and how students learn [18-21]. Assessment of PBL can be done by using scenario-based multiple-choice questions, extended matching, essay questions (cognitive knowledge) and OSCE (for assessing clinical knowledge and skills) [22-26]. Participants will be scored on their ability to: generate questions, identify the problem, state the problem definition, explain the relation between the solution and the problem, assessment of the solution, offer a solution, use the literature to support that solution and use other resources to support that solution.

Initial instruction classes will be taken in the classrooms for both the groups which can be used to create a knowledge base. Handouts regarding detailed learning objectives will be given to the students.

Ethical clearance will be obtained from the Institutional Review Board (IRB) for Human Research. Informed consent will be taken from each participant (Appendix).

Table-1: Examples of MCQs

Sl.No	STEMS AND OPTIONS
1	Following is a broad spectrum anti microbial agent a) Penicillin G b) Chloramphenicol c) Streptomycin d) Erythromycin
2	Cross resistance can be developed between erythromycin and a) Chloramphenicol b) Clindamycin c) Rifampicin d) Cefotaxime
3	Super-infection is caused by a) Penicillin b) Tetracycline c) Cefazolin d)Vancomycin
4	Cotrimoxazole is a combination of Trimethoprim and a) Sulfadiazine b) Sulfadoxime c) Sulfacetamide sodium d) Sulfamethoxazole
5	Sulfonamides are used to treat a) Brucellosis b)Urinary tract infection c)Tuberculosis d)Leprosy

Table-2: Likert's scale questions/items for students.

Please indicate your response to each item below regarding the instruction methods viz., LBL and PBL on the following scale.

(5- Strongly agree, 4- Agree, 3-Neither agree or disagree, 2-Disagree, 1- Strongly disagree)

Sl.No	Items: The instruction method has/had	LBL	PBL
1	listed useful objectives of the sessions		
2	Helped me in effective comprehension and application of pharmacology content knowledge.		
3	enhanced my transferable skills		
4	increased my confidence in managing complex patients who are taking multiple medications.		
5	enhanced my critical appraisal skill about the subject		

Table-3: Example of Problem/Case Study which may be given to the PBL group.

PBL Group 1- Case Study 1 (July/August, 2015)
Obesity is one of the modern non communicable disorders. Hyperlipidemia may cause many of the cardiovascular diseases. Cardiovascular diseases have many aetiological factors apart from hyperlipidemia. Your group is part of a medical team that is working in the Accident and Emergency department of the Hospital. Your task is to manage a patient who comes with a history of acute angina attack.
You have to find the details of the following: 1. What are the causes for chest pain?. 2. How angina pectoris is classified and what is the underlying mechanism?
Each member has to supply the following information about the: (a) Different drugs used in acute angina pectoris. (b) Pharmacological actions of nitrates. (c) Adverse drug reactions of nitrates.
A man aged 50 years comes to the Emergency department with history of severe chest pain. How do you approach the problem? You need the following information about the: 1. Reasons for acute chest pain. 2. Signs and symptoms of the acute angina? 3. Emergency management of acute cardiovascular conditions?
Answer to the case study is due in three parts. Last dates have been indicated below and for each deadline; details of the answers to be found and a suggestion to the number of pages for each section are given. Answers should be written in Times New Roman, 12 point font, double spaced. All material should be presented in electronic form and should be e-mailed to Dr. Suneel (suneelmajagi@yahoo.co.in) by 8 p.m. on the deadline date.
July. 18th:
(a) Classification of Angina Pectoris and the mechanism involved. (0.5 page) (b) A description of the mechanism of action and pharmacological actions nitrates. (1 pages) (c) Classification of drugs used in Angina Pectoris. (0.5 page) (d) A description of adverse drug reactions of the nitrates (0.5 page)
July. 24th:
(a) A discussion on the history of the patient including the paper procedures required at the time of admission of the patient (1 page) (b) A discussion on the initial management of the patient in the emergency department.(1 page)
July, 28th:
(a) A discussion on the drugs used in the angina pectoris including monitoring of the drugs. (1 page) (b) A discussion on the prognosis of the patient on a long run. (1 page) (c) A discussion on the general management of the patient.

STATISTICAL TESTS

Data will be collected after correction of the answer papers. Data will be expressed as Mean ± S.E.M. For both the intervention group, scores of post-test (O2 of each group) will be compared with that of pre-test (O1 of each group) [60 MCQs] by using (student's) paired't' test respectively. Unpaired't' test will be used to compare the difference between post-test and pre-test (Mean± S.E.M) of both (LBL and PBL) groups. Similarly, *only* post (intervention) test scores (120 MCQs) of both the groups (O3) will be compared by using unpaired't' test. OSCE scores of both the groups can be compared by using unpaired't' test whereas attitude tests' scores (Likert's-type items/questions) (O5) will be analysed by using Chi-square test. In LBL group, scores of pre-test for

cognition regarding PBL (O6 of PBL-60 MCQs) will be compared with that of post-test (O7) by using paired 't' test. Feedback regarding PBL will be given to the respective student by the experts. $P<0.05$ will be considered as significant for all the tests.

RESULTS AND DISCUSSION

Study results may suggest that PBL can be used as an adjunct or as a replacement for the LBL in pharmacology. It is essential to train doctors in: self-directed learning to be up to date with the current knowledge, key 'transferable skills' in pharmacology like solving problems in therapeutics, rational prescription of drugs for a disease condition and delivering drug, disease-related information in a meaningful way to patients, professionalism etc., [10, 27-30]. PBL will be useful to satisfy these needs. Students develop problem-solving skills, formulate evidence-based decisions and enhance their communication skills [31-34].

Although there has been some concern about the value of PBL, over and above lecture-based learning, in terms of knowledge acquisition [35], there have been a number of studies conducted in a variety of countries which indicate that PBL does not disadvantage students [33, 36-39]. Moreover students clearly indicate a preference for this type of learning [38, 40-42] and there is some evidence to suggest that medical students following PBL curricula are better disposed towards research [43], and show significant improvements in preventative care and diagnostic performance in practice after graduation [44]. A six-step process for decision making viz., evaluating the problem, collecting new information, building mechanisms, designing a management plan, selecting drug(s) and monitoring of therapeutic efficacy and safety has been proposed [2,15].

PBL has important cross-cultural implications due to globalization [1]. In our set up LBL is routinely used in the Department of pharmacology for undergraduates. Introduction of PBL will be an innovative effort which may help the learners to develop powerful habits of mind that enable them to: think critically; think creatively; regulate their behaviour; improve their self efficacy, team directed learning; obtain and evaluate literature; apply this information to patient cases. Handling the real world cases through PBL will be of real help when the students move to their next phase/class where they have to teach the clinical subjects which involve diagnosing and prescribing the treatment to the patients. PBL can be included in the student's assessment viz., sessional, preliminary or final examinations.

Any change in the existing system is likely to encounter the resistance and challenges at multiple levels. PBL methodology is expensive to implement [45]. PBL is associated with significant resource implications particularly in large classes [46]. Increased retention of information, an integrated (rather than discipline bound) knowledge base, the development of lifelong learning skills, an exposure to real-life experience at an earlier stage in the curriculum, increased student-faculty interactions, and an increase in overall motivation are some of the benefits that have been previously identified [47,48,49]. The self-study and group discussions develop skills, including self-directed learning, interdisciplinary knowledge creation and collaborative skills. The entire process is very interactive, achieving the goal of student engagement in learning, which has been shown to improve retention and satisfaction [50]. Novice tutors may be unable to fully convey the 'philosophy' of self-directed, reflective learning [51,52]. Special attention should be paid to the training and selection of PBL tutors who have a critical role in the PBL process [4]. A significant correlation between students' perception of tutor effectiveness and a number of tutor behaviours, including those related to both knowledge of subject matter and facilitation skill has previously been documented [53]. Initial investment in terms of efforts, cost, time, training of human resources in PBL will be valuable in the long run to the University policy makers, faculty and to the students.

The presentation has to be made user friendly and self explanatory. Collaboration has to be established as PBL needs a close cooperation of pharmacologists with their fellow scientists from other disciplines as well as with educational designers and clinicians [17]. Teachers need strategies and structures that connect theory with practice [54].

CONCLUSION

Present study is a conceptual paper and practicability of the same has to be confirmed. Introduction of PBL will be an innovative effort which will shift passive learning towards active learning. PBL can be updated or modified according to the newer knowledge/methods as and when necessary. Findings of the present study may be used for other disciplines and in broader studies focused on the design and development of integrated PBL (horizontal or vertical) for undergraduate students.

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APPENDIX
INFORMED CONSENT

Title of Research Study: Introduction of problem based learning and its comparison with conventional lecture based learning in pharmacology for undergraduates**.**

Objective/purpose of the study: will be explained to the students/participants.

Procedure: will be explained to the participants.

Risk: -Nil-

Benefits: will be explained to the participants and also how the study will be contributing towards improvement in teaching and learning will be explained.

Withdrawing/removal from the study: students have the freedom to participate or not.

Privacy and Confidentiality: will be maintained. Names of the students will not be revealed.

Financial incentives for participants: There will be no monitory benefits. Study will be carried out during routine teaching hours..

Contact details: of the principal investigator will be given.

CONSENT STATEMENT

(To participate in the study)

Details of the present study have been explained to me. I am aware that my participation in the present study is voluntary and I can withdraw at any time. I, the undersigned, have been given enough time to understand and clarify my doubts about the present study and my rights as a study participant.

Participant's name: _____

Signature of Participant: _____

Principal Investigator's name: _____

Signature of the principal investigator: _____

Place:

Date: